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DISTINCTION BETWEEN SALMONELLA AND ARIZONA BY LEIFSON'S SODIUM MALONATE MEDIUM

Constance Shaw

National Collection of Type Cultures
London, England

A sodium malonate medium was used by Leifson (1953) for separating Escherichia coli from Aerobacter aerogenes. Later Schaub (1948) found that her subgroup C of Group II paracolon bacilli (similar to organisms described by Peluffo, Edwards, and Bruner (1942), Edwards, Cherry, and Bruner (1943) and Hinshaw and McNeil (1945)) could be distinguished from Salmonella species by a sodium malonate test, slow lactose fermentation, and delayed liquefaction of gelatin. Using Leifson's sodium malonate medium as one of the routine biochemical tests on members of the Enterobacteriaceae, phenylalanine was added for the detection of Proteus and Providence strains (Shaw and Clarke, 1955) and our results agreed with those of Schaub. The presence of phenylalanine did not affect the reading of the malonate test.

Methods

Strains. The cultures of Salmonella and Arizona examined were those maintained at the National Collection of Type Cultures.

Medium and malonate test. Leifson's (1933) sodium malonate and Henriksen's (1950) phenylalanine tests were combined by adding phenylalanine to Leifson's medium. 0.1 per cent Yeastrel was added to increase growth. The medium was as follows: $(NH_4)_2SO_4$, 2.0 g; K_2HPO_4, 0.6 g; KH_2PO_4, 0.4 g; NaCl, 2.0 g; sodium malonate, 3.0 g; DL-phenylalanine, 2.0 g; Yeastrel, 1.0 g; 0.5(w/v) ethanolic bromthymol blue, 5 ml; distilled water, 1000 ml. It was sterilised at 10 lbs/sq.in. for 10 min. Cultures were incubated overnight at 37°C; organisms using malonate produced an alkaline reaction.

Results

Table 1 gives the results of the test on Salmonella spp. and Arizona strains, and shows that most of the Arizona strains were malonate-positive, i.e., produced alkali in the malonate medium. The five Arizona strains that failed to change the pH in the malonate medium were biochemically typical strains in that they were late or non-lactose fermenters and failed to produce acid in dulcitol.

Table 1. Utilization of Sodium Malonate by Salmonella and Arizona strains.

	Number tested	Number positive	Per cent	Number negative	Per cent
Salmonella	228	11	4.8	217	95.2
Arizona	67	62	92.5	5	7.5

Salmonella spp. were mostly malonate-negative. The 11 strains that caused a pH change in the malonate medium were Salmonella dar-es-salaam (NCTC 2206 and NCTC 5773), S. canastel (NCTC 6948), S. neasden (NCTC 7835), S. marylebone (NCTC 9605), S. worcester (NCTC 8273), S. nachshonim (NCTC 8280), S. rowbarton (NCTC 9606), S. bleadon (NCTC 9604), S. taunton (NCTC 9600) and S. uphill (NCTC 9581). All these strains except S. marylebone and S. taunton were described by Kauffmann (1954) as liquefying gelatin, but when examined by us some of them failed to do so within 30 days at 22°C. All were non-lactose fermenters and produced acid and gas from dulcitol. Five of the strains belong to serological groups D or G, and the remainder are recently described strains from tortoises (Boycott, Taylor, and Douglas, 1953; Douglas and Taylor, 1954).

Discussion

Salmonella and Arizona strains have many biochemical characters in common, and differ mainly in the ability of Arizona strains to liquefy gelatin when incubation is prolonged for a month or more. However, a few Salmonella serotypes are known to liquefy gelatin, and strains of some

of these serotypes were shown to produce an alkaline reaction in Leifson's malonate medium.

The majority of Arizona strains were malonate-positive, but the few that were negative seem to form, with the malonate-positive salmonellas, intermediate links between the Arizona and Salmonella groups. With the exception of Salmonella marylebone and S. taunton all the malonate-positive Salmonella serotypes were originally described as gelatin-positive, and consequently they differed in their biochemical characters from the Arizona group only in being dulcitol-positive.

Serologically there is much overlapping of antigens between the Arizona and Salmonella groups (Edwards, West, and Bruner, 1947) and in several instances the antigens are identical. Thus, with so many biochemical and serological characters in common, it would seem logical to regard the Arizona group as a species of the genus Salmonella. The malonate test would help to distinguish this species.

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DIMINUTIVES AS GENERIC NAMES IN BACTERIOLOGY

R.E. Buchanan

Many names of genera used in each of the subdivisions of biology (botany, bacteriology, and zoology) have a diminutive suffix. Bacterium, Bacteridium, Bacillus, and Bactridium all have the meaning of "small rod."

The nomenclatural code of each branch of biology clearly approves of the formation of a generic name from the name of a person; generic names are frequently thus dedicated; rather commonly they have a suffix indicating diminution. Usually the generic name is derived from a modern surname.

The zoological "Rules" include two pertinent recommendations (not rules) among the statements relative to the classes of words that may be taken as generic names. One relates to the ending of modern surnames to indicate dedication.

> "Names terminating with a consonant take the ending -ius, -ia, or -ium." (Examples: Selysius from Selys, Lamarckia from Lamarck). "Names terminating with the vowels e, i, o, u, or y take the ending -us, -a, or -um." (Examples: Blainvillea from Blainville, Wyvillea from Wyville, Cavolinia from Cavolini, Fatioa from Fatio, Bernaya from Bernay, Quoya from Quoy, and Schulzea from Schulze). "Names terminating with a take the ending -ia." (Example: Danaia from Dana).

Of the generic names given as examples above, with the exception of the masculine Selysius, all end in -a, and are feminine. No example of the use of the neuter ending -ium or -um is included. The tendency in zoology (as in botany and bacteriology) is to put generic names derived from surnames in the feminine form.

The second pertinent zoological recommendation approves the use of:

> "Greek or Latin derivatives expressing diminution, comparison, resemblance, or possession."

The recommendation was evidently not intended to authorize

the addition of endings implying diminution in forming generic names from modern surnames. There are many examples, however, among generic names in zoology so derived, as Prowazekella from Prowazek, Schultzella from Schultz, Schaudinnula from Schaudinn, Challengeretta from the ship Challenger, as well as Challengeridium and Challengerilla.

The corresponding recommendations in bacteriology and in botany relative to derivation of a generic name from the name of a person are practically identical except for the examples cited. The Recommendation of the Bacteriological Code reads:

> "When a new name for a genus or subgenus is taken from the name of a person, it should be formed in the following manner:
>
> 1. When the name of the person ends in a vowel the letter -a is added (thus, Gaffkya after Gaffky; Noguchia after Noguchi; Serratia after Serrati), except when the name already ends in -a, then -ea is added (e.g., Collaea after Colla).
> 2. When the name of a person ends in a consonant the letters -ia are added (e.g., Escherichia after Escherich, Erwinia after Erwin F. Smith, Pasteuria after Pasteur), except when the name ends in -er, then -a is added (e.g., Kernera after Kerner). In latinized names ending in -us, this termination is dropped before adding the suffix."

These recommendations have not always been followed in bacteriology; the names formed in contravention to the recommendations are not illegitimate as a result. For example, Neisseria (after Neisser) instead of Neissera and Zopfius (after Zopf) instead of Zopfia are in acceptable form.

An additional Recommendation in the Bacteriological Code (similar in wording to that of the Botanical Code) reads:

> "Names may be formed by use of a prefix or a suffix, or modified by anagram or abbreviation. In these cases, they count as different words from the original name. In many cases, the names of bacterial genera are formed by the addition of a diminutive ending. The most common modern convention is to add one of the endings,

-ellus, -ella, -ellum, preferably -ella, to conform to Recommendation 5a.* In some few cases one of the endings -illus, -illa, -illum has been added."

There is no reason why other diminutives than those indicated above may not be used in the formation of names from personal names (patronymics). A brief review is here given of classical diminutive endings and the ways in which they have been and may be employed.

The Latins used several diminutive suffixes, usually various modifications of -lus, -la, -lum. The exact form of the diminutive ending varies somewhat with the ending of the word to be modified.

1. Words in which the stem ends in -g, -c, -d, or -t usually form the diminutive by adding -ulus, -ula, or -ulum, sometimes -lus, -la, or -lum. For example;
   rex, regis (stem reg-) a king; regulus, a chieftain;
   vox, vocis (stem voc-) voice; vocula a small voice;
   hortus a garden; hortulus a little garden;
   oppidum a town; oppidulum a little town.

2. Words that end in -us, -a, or -um preceded by e, i, or u, usually form the diminutive by dropping the gender ending and adding -olus, -ola, or -olum. Thus,
   alveus a cavity; alveolus a small cavity;
   gladius a sword; gladiolus a small sword;
   bestia a beast; bestiola a little beast.

3. Words that end in -us, -a, or -um preceded by l, r, or n, usually change the vowel just preceding the consonant to e, and the l, r, or n to ll. Where another consonant immediately precedes the l, r, or n the vowel e is inserted. As a result, many diminutives of Latin nouns end in -ellus, -ella, or -ellum.
   asinus an ass; asellus a little ass;
   fabula a story; fabellus a short story;
   umbra shade; umbella a little shade, an umbrella.

*Recommendation 5a (6) suggests giving a "feminine form to all personal generic names, whether they commemorate a man or a woman."

In other words, the suffix -ella so commonly appended in forming generic names was not a standard Latin suffix, but was developed only for certain words. In view of its general use as a suffix for modern Latin generic names, there would seem to be good reason for accepting it as a standard diminutive ending, at least wherever it is euphonious.

4. The diminutive ending -illus, -illa, -illum sometimes used with patronymics (Welchillus, Meyerillus, Henrillus) to form a diminutive apparently arose from analogy. The Latin diminutive of lapis, lapidis a stone is lapillus. This has apparently been equated with -ellus, -ella, -ellum. It has been used by but few authors. This ending is found in the Latin nouns bacillus and bacillum.

5. Latin stems that end in l, n, r, or s, or in i, u, or e add -culus, -cula, -culum, frequently changing the vowel preceding the final stem consonant to u.
   homo, hominis (stem homin-) a man; homunculus a manikin;
   virgo, virginis (stem virgin-) a maid; virguncula a little maid;
   ignis (stem igni-) a fire; igniculus a spark;
   vulpes a fox; vulpecula a little fox;
   canis a dog; canicula a small dog.

6. The frequency of diminutives formed as noted under No. 5 supra also led to the recognition of -unculus, -uncula, -unculum as derived suffixes.
   rana frog; ranunculus a little frog, a tadpole;
   domus a house; domuncula a little house.

7. The suffix -cio may indicate a diminutive,
   homo, hominis a man; homuncio a manikin.

8. The suffixes -leus, -lea, -leum may be diminutive,
   acus a pin; aculeus a sting.

9. The suffix aster, astris may be a diminutive, as in Antoniaster, a little Anthony, an imitator of Anthony.

10. The suffix -itta was occasionally used to form the diminutive of a name as Iulitta from Iulia and Pollita from Polla (Paula).

The Greeks also recognized several diminutive endings to be used as suffixes for nouns. Most common were:

1. - ιον = -ium.
   παῖς, παιδός = paes, paedis a child;
   παιδίον = paedium a little child;
   πτέρυξ, πτέρυγος = pteryx, pterygis a wing;
   πτερύγιον = pterygium a little wing.

2. - υδιον = -idium.
   οἶκος = oecus house;
   οἰκίδιον = oecidium a little house.

3. - αριον = -arium.
   παῖς, παιδός = paes, paedis a child;
   παιδάριον = paedarium a young child.

4. - υδριον = -ydrium.
   πόλις = polis a city;
   πολύδριον = polydrium a small city.

5. - υλλιον = -yllium.
   ἄνθος = anthus flower;
   ἀνθύλλιον = anthyllium a small flower.

6. - ισκος = iscus.
   κλάδος = cladus a shoot of a tree;
   κλαδίσκος = cladiscus a small shoot.

7. - ισκη = -isce.
   παῖς, παιδός = paes, paedis a child;
   παιδίσκη = paedisce or paedisca a small girl.
   ἀσπίς, ἀσπίδος = aspis, aspidis a round shield;
   ἀσπιδίσκη = aspidisce (or aspidisca) a boss, knob.
   μάζα = maza a barley-scone;
   μαζίσκη = mazisce or mazisca a small scone.

8. -iota, the smallest letter of the Greek alphabet, has been used as a suffix to denote diminution in names of genera derived from personal names, as Colesiota and Borreliota.

One may summarize the utility of diminutive suffixes in the formation of new generic names as follows:

1. The following suffixes expressing diminution seem suitable for use in making new generic names from Latin words. For most of them there is precedent.
   a. -ulus, -ula, -ulum
   b. -olus, -ola, -olum
   c. -ellus, -ella, -ellum
   d. -illus, -illa, -illum
   e. -culus, -cula, -culum
   f. -unculus, -uncula, -unculum
   g. -cio, -leus, -aster, and -itta rarely.

2. The following suffixes expressing diminution seem suitable for use in making new generic names from Greek words.
   a. -ium
   b. -idium
   c. -arium rarely
   d. -ydrium rarely
   e. -yllium rarely
   f. -iscus and -isce (-isca)
   g. -iota.

Note that with the exception of -iscus (masculine) and -isce or isca (feminine) the other Greek diminutive endings are neuter and that, in the Greek, iota is an indeclinable neuter noun, as are the names of most Greek letters.

3. Diminutives that may appropriately be used for addition to personal names should preferably conform to the Recommendation that a feminine form be given to all personal names. These presumably could be either Latin or transliterated Greek feminine endings. These would be

   -ula, -ola, -ella, -illa, -cula, -uncula, -itta, -isce, -isca.

Whether or not iota, when used as a suffix or as the last component of a compound generic name, should confer neuter gender on the noun may be debated. Harper's Latin Dictionary, 1907, lists iota as a neuter indeclinable noun, but adds "sometimes (on account of littera) iota, ae. f." An example of such use as a feminine noun is cited: "littera iotae similis." The gender of generic names ending in -iota was not fixed by usage in the genera Colesiota and Borreliota.

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NOMENCLATURAL SIGNIFICANCE OF -IASIS, -OSIS, AND -ITIS AS SUFFIXES IN NAMING DISEASES

R.E. Buchanan

The Greeks named many diseases, frequently by use of three suffixes, -iasis, -ōsis, and -itis, added to suitable stems of verbs or nouns. These Greek precedents have commonly been followed to the present in the nomenclature of disease. Furthermore, there are, in the literature of microbiology, numerous examples of names of microorganisms (particularly specific epithets) derived from the name of the related disease. Some uncertainty has been expressed as to the formation of the genitives of words formed by the use of the three suffixes due to the fact that each has the ending -is in the nominative; the first two have as the genitive -iasis and -ōsis, respectively (same as the nominative), but the third -itis has as the genitive -itidis. One finds Mycobacterium tuberculosis, but Salmonella enteritidis. A brief review of the origin, meanings, and uses of these suffixes seems desirable.

The Greek Suffix - ιασις = -iasis

Buck and Petersen, in their "Reverse Index of Greek Nouns and Adjectives" list about 4350 Greek words with the termination - σις = -sis. Almost all are feminine nouns. Of these about 130 have the ending - ιασις = -iasis. The Greeks derived these nouns frequently from verbs having the meaning "to suffer from a disease." Some examples may be given.

λιθιάω = lithiaō to suffer from the stone;
λιθίασις = lithiasis the disease of the stone (urinary calculus).
δυσουριάω = dysuriaō to have retention of urine;
δυσουρίασις = dysuriasis dysuria
ἐλεφαντιάω = elephantiaō to suffer from elephantiasis.
ἐλεφαντίασις = elephantiasis.

Transliteration of some others of the Greek names of diseases will show the character of this use.

crithiasis a mange of the horse.
alopeciasis fox mange.
thriciasis a shivering.
heliasis sunstroke.
bulimiasis suffering from ravenous hunger.
scotodiniasis dizziness, vertigo.
nyctalopiasis night blindness.
hydropiasis dropsy.
mydriasis enlargement of the pupil of the eye.
hyderiasis dropsy.
scleriasis an induration of the eyelid.
phthiriasis lousiness, pediculosis.
siriasis sunstroke.
stenocoriasis contraction of the pupil of the eye.
satyriasis satyriasis, priapism.
pityriasis scurf.
ochriasis a turning pale, paleness.
poriasis a callus on the eye.
psoriasis itch or scab.
nausiasis qualmishness.
celephiasis leprosy.
gomphiasis toochache.

In general, it is clear that when used as an ending for the name of a disease -iasis means "a disease characterized by the presence of." The diagnostic feature may be the symptoms of the disease (alopeciasis, thriciasis), the parasite present (phthiriasis), a lesion of pathological change characteristic of the disease (poriasis).

Appropriately the suffix -iasis is added to Greek stems. Many names of diseases have been formed by adding this ending to the stem of the generic name of the causal organism. However, such names may be of Latin origin. There is now ample precedent for naming diseases by use of -iasis with Latin or modern Latin stems, as filariasis from filaria.

Names of diseases ending in -iasis when used in specific epithets are feminine nouns, to be placed in the genitive. They are in the third declension.

ψωρίασις, εως = psoriasis, eōs.

When transliterated into Latin form, these names are placed in the corresponding Latin declension, as psoriasis, -is. The genitive and nominative forms are the same. Should one describe a new species of Mycobacterium associated with leprosy, it might appropriately be termed Mycobacterium celephiasis (the Mycobacterium of leprosy).

The Greek suffix -ωσις = -ōsis.

About 900 of the Greek words which end in -sis (more than 4300 in all) have the termination -ωσις = -ōsis. They are feminine nouns. Here again, the Greeks sometimes derived these nouns from verbs having some connotation relating to disease. As examples:

συριγγόω = syringoō to grow hollow, to end in a fistula;
συρίγγωσις, εως = syringosis, -is, the formation of a fistula.

χαλαζάω = chalazaō to have pimples or tubercles;
χαλαζωσίς, εως = chalazosis, -is tuberculousness, tuberculosis?

νάρκάω = narcaō to become numb;
νάρκωσις, εως = narcosis, -is, a benumbing.

Other transliterations of similar Greek names of disease will illustrate.

thrombosis a becoming curdled.
phalangosis ingrowing eyelashes.
phlogosis burning heat, inflammation.
rhytidosis a wrinkling, contraction.
lithosis hardening, a turning to stone.
peliosis a livid spot.
heliosis exposure to sun.
poliosis a becoming gray
theriosis a turning into a beast.
stranguriosis strangury, difficulty in urination.
nausiosis a vomiting.
rhacosis a becoming wrinkled.
anthracosis a malignant ulcer (eye).

leucosis a white spot (cataract) in the eye.
glaucosis blindness from glaucoma.
syrcosis ulcer (like over-ripe fig) of the eyelid.

When used as an ending for the name of an abnormality or disease, -ōsis means "characterized by the presence of," not differing essentially in meaning from that given by the suffix -iasis. In fact, the Greeks in a few cases used both endings. The something present may be a symptom, a lesion, an associated parasite, or some other characteristic.

While more appropriately added to the stems of Greek words, the ending -ōsis has frequently been used in the formation of names of diseases by addition to Latin or modern Latin stems, as in tuberculosis, brucellosis, listeriosis, and sarcinosis.

The Latin genitive of the name of a disease ends (as the nominative) in -ōsis, as in Mycobacterium tuberculosis (the Mycobacterium of tuberculosis).

The Greek Suffix -ιτις = -itis

In the Greek there are about 2400 words (nouns and adjectives) having the ending -ις, -ιδος = -is, -idis. Of these about 300 have the ending -ιτις, -ιτιδος = -itis, -itidis. Many of these are feminine adjectives. Among these are some derived from the names of parts of the body, and used to modify the feminine noun νόσος = nosus sickness or disease. For example, νόσος νεφρῖτις = nosus nephritis, disease of the kidneys, from νεφρός = nephrus kidney. Generally, in referring to diseases the noun nosus was omitted, and the adjective was treated as a noun and as the name of the disease. As stated by Buck and Petersen:

> "An excursive group of this type consists of names of diseases in -itis, productive in international medical nomenclature even at the present time."

As stated in Dorland's Medical Dictionary:

> "The feminine form, -itis, is so often associated with inflammatory disease, that it has acquired in most cases the significance of inflammation."

Some examples from the Greek:

φρήν = phren mind;
φρενῖτις, -ιδος = phrenitis, -itidis inflammation of the brain, phrenitis.

ἄρθρον = arthrum a joint;
ἀρθρῖτις, -ιδος = arthritis, -itidis gout, arthritis.

ἧπαρ, ἥπατος = hepar, hepatis the liver;
ἡπατῖτις, -ιδος = hepatitis, -itidis of or in the liver, hepatitis.

Among the many other names of diseases taken directly from similar Greek adjectives are:

sphagitis, -itidis sore throat.
syringitis, itidis inflammation of the Eustachean tube.
splenitis, itidis inflammation of the spleen.
blepharitis, itidis inflammation of the eylids.
pleuritis, itidis pleurisy.
nephritis, itidis nephritis.

In forming names of diseases from names of organs or tissues, the ending -itis has come to be added not only to Greek stems (as in gastritis, stomatitis) but to Latin stems as well (appendicitis, sinusitis, gingivitis).

Names of diseases in modern Latin ending in -itis are feminine nouns and have as the genitive ending -itidis.

SUMMARY

Names of diseases with the suffix -iasis are modern Latin feminine nouns with the genitive ending also -iasis.

Those with the suffix -ōsis are also modern Latin feminine nouns with the genitive ending -ōsis.

Those with the suffix -itis are modern Latin feminine nouns with the genitive ending -itidis.

These endings, while more correctly used with Greek stems, are commonly added also to Latin and to modern Latin stems.

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EDITING AND PUBLICATION OF THE REVISED INTERNATIONAL CODE OF NOMENCLATURE OF THE BACTERIA AND VIRUSES

Editorial Board

R.E. Buchanan, S.T. Cowan, and T. Wikén

The following draft proposal was approved unanimously by the Judicial Commission, by the International Committee on Bacteriological Nomenclature, and by the Plenary Session of the International Microbiological Congress held in Rome (September 1953).

> The Editorial Board and the Judicial Commission are requested to edit and publish an "official" International Bacteriological Code of Nomenclature.* It is desirable that there be included texts in one or more other languages (than English), including to the extent practicable French, German, and Spanish. It is proposed that the revised Code be annotated, and that there be included examples drawn from Bacteriology of the effect of the rules. As Appendices are to be included lists of nomina conservanda and of nomina rejicienda, and such other statements as are recommended by the Judicial Commission and approved by the International Committee.

It was agreed that consideration of publication in languages other than English would be by letter ballot.

The Editorial Committee and Judicial Commission have published reports of all actions taken by the Judicial Commission and the International Committee (1,2,3,4) at the Rio de Janeiro (1950) and Rome (1953) meetings. A series of Opinions (Nos. 1-14) have been approved and published. The Annotation of the Code is well under way.

This communication is to acquaint the members of the International Committee and all interested in bacteriological nomenclature of the proposed outline of the revised Bacte-

*A later resolution, duly approved, directed that the name of the revised code should be the "International Code of Nomenclature of the Bacteria and Viruses," and that the abbreviated title "Bacteriological Code" be recognized.

riological Code, and to detail and illustrate the technique of presenting the draft to the Judicial Commission for needed revision and emendation before publication.

The Judicial Commission has several authorizations:

1. It is directed to study the corresponding provisions of the Botanical and Zoological Codes in order to harmonize the rules and recommendations where this seems practicable and desirable.

2. It is authorized to make such editorial changes as are needed to harmonize the several parts of the Code.

3. It is directed to prepare and secure approval of a series of appendices.

4. It is directed to consider the problem of publication of translations of the Bacteriological Code into languages other than English.

1. Study of Botanical and Zoological Codes. The nomenclatural codes, both in botany and in zoology, have been undergoing much revision. The 13th and 14th International Zoological Congresses (Paris 1948 and Copenhagen 1953) approved in principle a rather sweeping series of changes in the rules. The several directives were published in the Bulletin of Zoological Nomenclature and in the Copenhagen Decisions on Zoological Nomenclature (1953). In most cases no exact and definitive wording of the rules were given, but usually a general directive with the exact phraseology and arrangement to be drafted by Professor J. Chester Bradley, the Editor. No publication of the revised code has appeared, and no direct comparisons of wording are possible. However, the issue of an "Unofficial Interpretation of the International Rules of Zoological Nomenclature" by W.I. Follett has proved of great assistance in making available a summary of all pertinent actions, together with a glossary of technical nomenclatural terms and phrases, and a well organized index. Because of the ownership of the copyright of the rules when published and the special restrictions imposed by the International Trust for Zoological Nomenclature, the title page bears the strange statement,

"Issued September 1955
Not published"

The preface states further:

> This paper is not issued for purposes of record, but only for the particular purposes of study and discussion during a limited time. Therefore, it falls within the definition of an unpublished document (The Bulletin of Zoological Nomenclature, 4(7/9), 1950:217-218) and it should not be quoted as authority for any nomenclatural proposition. Immediately upon the publication of Professor Bradley's official draft of the revised Rules, this paper will become obsolete.

In spite of the form of publication, or lack of it, the summary has proved most helpful, due in no small measure to the ease of reference to source material. It is evident, however, that critical comparisons between wordings of the Zoological and Bacteriological Codes must wait upon a future edition of the latter.

The situation with reference to the Botanical Code is somewhat better. The minutes of the Section on Nomenclature of the Eighth International Botanical Congress have recently been published in Taxon (4:121-177. 1955). This gives the vote of the Section on the numerous proposals that had previously been published in "Recueil Synoptique," Regnum Vegetabile 4:1-124, 1954, and the "Geneve Conference on Botanical Nomenclature and Genera Plantarum." Regnum Vegetabile 5:1-59, 1954. The definitive text has not yet appeared.

It has been thought best to proceed with the publication of the Bacteriological Code, even though not all desirable comparisons with the Zoological and Botanical Codes are possible.

2. Authorization to edit the Code. The Bacteriological Code will continue to have the same chapter headings as in the 1947 (Copenhagen) edition. The outline follows:

Preface.
Chapter I. General Considerations and Definitions.
Chapter II. General Principles.

Chapter III.	Rules of Nomenclature with Recommendations.
Section 1.	Naming of groups of various ranks.
Section 2.	Designation of nomenclatural types.
Section 3.	Publication of names.
Section 4.	Citation of authors and names.
Section 5.	Changes in names as a result of segregation or union of taxa or change in rank of taxa.
Section 6.	Rejection and replacement of names.
Section 7.	Orthography and gender of names.
Chapter IV.	Provisions for exceptions to the rules and for interpretation and modification of rules.
Chapter V.	Appendices.

In spite of the rather numerous changes in wording, deletions, and additions, it has not been necessary materially to change the order or the numbering of the rules. This will facilitate the comparison of the Copenhagen (1947) Code with the Rome (1956) Code.

The following technique has been put into effect for the final editing of the Bacteriological Code. The copy is first prepared by the Editorial Committee, then duplicated and sent to each member of the Judicial Commission for criticism and emendation. Changes suggested will again be circularized, and final wording agreed upon. Unfortunately it will not be practicable, though desirable, to send copies of drafts to all of the approximately one hundred members of the International Committee, because of the expense of duplication and mailing. If there are members of the Committee who are desirous of receiving these preliminary drafts they may be secured by sending to one or the other of the Permanent Secretaries or to the Chairman of the Editorial Committee a sum adequate to pay mailing costs (to be determined by correspondence).

The draft copy of Chapters I and II and of Chapter III, Section 1, Rules 1-8 have been mailed to the members of the Judicial Commission.

The directive that the Code be adequately annotated with explanations and examples has posed some real problems. How much explanation is needed? And in what detail? To many the Annotations as prepared may seem unnecessarily detailed, that somewhat more of knowledge of the principles of biological nomenclature can be expected of the reader.

However, the scientific names of microorganisms are probably used by a greater variety of professional workers and scientists than are those of any other group of plants or animals. Some knowledge of how bacteria are named is needed by bacteriologists in many fields, by agronomists, botanists, plant pathologists, physicians, dentists, laboratory technicians, physiologists, protozoologists, veterinarians, biochemists, enzymologists, geneticists, nurses, sanitary engineers, food technologists, specialists in the antibiotic field, limnologists, algologists, public health officials, and many others. Some of these have a good background in taxonomy and nomenclature, the majority have not. The Annotations are intended to assist those who have little training in Latin (and usually none in Greek) to understand how organisms are named, particularly to aid those who wish to coin a new name for a taxon, to determine the correct name of two or more that have been used, how to choose the correct name to be used when taxa are split or united, or how to determine the etymology of scientific names and epithets. The rules, recommendations, and annotations should be so worded as to be of maximum assistance.

To illustrate the procedure in submission of the Code to the members of the Judicial Commission, two excerpts are published herewith as Exhibits 1 and 2. One is the draft copy of "General Considerations" of Chapter I with its Annotations, the second is Chapter III, Section 1, Rule 4.

The official text of the Bacteriological Code will be given in larger print, followed by the Annotations giving explanations, discussions and examples.

Note that the two draft copies given as Exhibits 1 and 2 are not in final form, but are for emendation and final revision, particularly as to the Annotations.

3. The directive to prepare a series of appendices. The Botanical Code, as well as the Bacteriological, authorizes the preparation and inclusion of several appendices. Instead of "Appendix" the term "Schedule" is used in the Zoological Rules.

To be included in the Appendices to the Bacteriological Code will be a schema for transliteration of Greek words for use in nomenclature in microbiology, alternative spellings of names and epithets in microbiology (orthographic variants), lists of conserved and rejected names, and summaries of Opinions rendered.

EXHIBIT 1

GENERAL CONSIDERATIONS AND DEFINITIONS

General Consideration 1. The progress of bacteriology can be furthered by a precise system of nomenclature which is properly integrated with the systems used by botanists and zoologists and accepted by the majority of bacteriologists in all countries. Bacteriological nomenclature considers bacteria, related organisms, and the viruses. Botanical and zoological codes provide for the nomenclature of certain groups such as the yeast and fungi, algae, and protozoa. These are of such significance in the microbiological laboratory that provision is necessary for the consideration of special nomenclatural problems in these groups and for coordination of findings with those of zoologists and botanists.

ANNOTATIONS

General Consideration 1. There is no court which is competent to enforce the several provisions of any nomenclatural code. Adherence to the rules and recommendations of the Bacteriological Code is left to the individual judgement of the microbiologist. Nonconformity seems to be due more to lack of knowledge of the code provisions or to lack of understanding of their intent than to fundamental disagreement with the provisions themselves. There are three official codes of nomenclature, one for each of the three segments of biology, botany, zoology, and bacteriology (including virology). The existence of three codes is troublesome, for the microbiologist works with microorganisms whose nomenclature is determined by the Bacteriological Code (the bacteria and viruses), by the Botanical Code (the fungi, algae, and slime molds), and by the Zoological Code (the protozoa). Fortunately, the more important rules of the three codes are similar, where they differ the differences are reasonably clear and understood. The rules and recommendations of

(Exhibit 1, continued)

the Bacteriological Code in general agree with those of the Botanical Code; wherever there are noteworthy differences between the provisions of the Bacteriological and the Botanical or Zoological Codes they will be discussed in the appropriate Annotation. When the rules and recommendations of the several codes are in conflict and lead to doubt as to the correctness or legitimacy of a name, General Consideration 1 suggests provisions for coordination through consultation with the appropriate representative committee of botanists or zoologists. The botanists, through action of International Botanical Congresses, have organized special committees and subcommittees to work on problems relating to particular groups of plants, such as for the algae, the fungi, the lichens, and the bacteria. Certain microbiological problems can be referred to such committees for advice or for action. The zoological rules also provide for committees of specialists to consider and make recommendations relative to problems of the several subdivisions of the animal kingdom. The Judicial Commission of the International Committee on Bacteriological Nomenclature is directed to work actively with the corresponding committees in zoology and botany on matters of common interest.

A statement (Art. 3) in the Botanical Code corresponding to General Consideration 1 reads:

> Botany requires a precise and simple system of nomenclature which is used by botanists in all countries.

A related statement in the Preamble of the International Rules of Zoological Nomenclature is:

> The object of the Rules is to provide a system under which the name of each taxon is unique and distinctive. A primary purpose is to insure the stability and universal acceptance of names. The Rules do not trespass on freedom of taxonomic practice.

EXHIBIT 2

Chapter III. Section 1. Naming of groups of various ranks.

Rule 4. Names of taxonomic groups (taxa) between subclass and genus have suffixes to fix the taxonomic rank. The suffix for orders is -ales, for suborders -ineae, for families -aceae, for subfamilies -oideae, for tribes -eae, and for subtribes -inae.

ANNOTATIONS

Rule 4. The suffixes specified in the Bacteriological Code for formation of names of higher taxa between subclass and genus and those authorized by the Botanical Code are identical. The Zoological Code specifies two suffixes only; all family names must end in -idae and subfamily names in -inae. No specifications as to the endings to be used for other higher taxa have been published.

The suffixes are all plural feminine adjective endings. The singular forms of these suffixes are -alis, -inea, -acea, -oidea, -ea, and -ina; -oidea is from the Greek, -ina may be either Greek or Latin, the others are Latin adjectival suffixes. All as here used have the connotation of "like" or "resembling" or "having the characteristics of." These endings are in the feminine plural as they in theory modify the plural Latin noun Plantae. The family name Spirillaceae literally has the meaning of "spirillaceous plants," that is plants (organisms) resembling those of the genus Spirillum. However, in modern nomenclature the names of taxa above genus are treated as plural substantives (nouns) and not as adjectives. Further discussion of the formation of names of higher taxa will be found in the Annotations in Chapter 7 under "Orthography and Gender of Scientific Names" (p.).

Occasionally (rarely) one finds the name of one of the higher taxa used in the singular. One may, for example, designate an organism as a Spirillacea meaning that it is one of the species belonging to the family Spirillaceae. This is done not infrequently in botany; the phrases, "this is a Rosacea" or "a new Rosacea" are briefer than "this belongs

(Exhibit 1, continued)

to the Rosaceae" or "a new species of Rosaceae." Apparently this usage has been confined almost entirely to the singular family names; however, such use of a family name in the singular is rare in microbiology.

Authors sometimes change the spelling of names of higher taxa to conform to the characteristic of the vernacular in which they write. In French the family name Spirillaceae may change from its Latin form to Spirillacées, in German to Spirillaceen (or more frequently Spirillazeen). Trevisan used as a title for an important taxonomic brochure, "I generi e le specie delle Batteriacee;" Billet used the phrase, "d'une nouvelle bacteriacée marins." This is not customary in English, one does not often find a spelling Spirillaceas. These words with the changed spellings are no longer Latin, they are vernacular, and are not the names authorized by the international agreements recognized by the several codes of nomenclature. They may be justified in nonscientific writing but cause difficulty when, as has happened, new names of higher taxa as families are proposed in the vernacular spelling. Does such a word have standing in nomenclature when not spelled as a Latin word? Should such words be discarded as not validly published and replaced, or should the incorrect spellings be regarded as unintentional errors and corrected? No formal Opinion has been rendered. It may be that the legitimacy of such vernacular names of higher taxa should be considered individually.

4. Transliteration of Bacteriological Code into languages other than English. Unofficial translations of the 1947 (Copenhagen) edition of the Bacteriological Code were published in French, German, and Spanish in France, Switzerland, and Argentina, respectively. The desirability of such translations and of their publication in a single volume with the English text is recognized. However, securing such translations for publication would much delay the appearance of the Code in printed form. The preparation of suitable translations will be undertaken in the hope that a complete edition containing these may be published later. The question will also arise as to the need for translation of the Annotations and Appendices.

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THE PRINCIPLES OF GROUP DIFFERENTIATION WITHIN THE ENTEROBACTERIACEAE BY BIOCHEMICAL METHODS

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In a recent paper on the philosophy of classification, Cowan (1955) posed two questions which are of fundamental importance in the classification of the Enterobacteriaceae:

1. "Does the hierarchial structure of a Linnaean system satisfy the requirements of microbiologists?
2. "Can we accept the species concept, and all that this implies, or must we view our organisms as a huge spectrum composed of gradually merging forms?"

Both of these questions must be answered in the negative as the Linnaean system cannot be used and the species concept in a Linnaean sense cannot be accepted. As has been pointed out the Enterobacteriaceae must be regarded as a "series of interrelated bacterial types which do not lend themselves to sharp division into tribes or into groups" (Enterobacteriaceae Subcommittee, 1954). Further, "The family is composed of a large number of interrelated types which display almost every conceivable combination of biochemical characteristics compatible with the definition of the family. These types form such a continuous series that they are not readily susceptible to division into distinct groups. A logical method of classification would be a catalog of this continuous series of types based upon their biochemical and serological properties since any attempt at grouping results in the exclusion of strains of intermediate character which do not conform to the properties established for each of the groups. However, our knowledge of the bacteria is so fragmentary and the types are so numerous that as a matter of expediency it is necessary to divide the family into groups which form the basis of practical work" (Edwards and Ewing, 1955).

Under these circumstances and since nothing is known concerning genetic relationships and evolutionary trends within the family, it is impossible to decide whether a given classification is scientifically correct, but only whether it is more or less practical and expedient. The whole problem must be regarded from the standpoint of practical diagnosis and in the light of our limited present knowledge. This attitude is reflected in the two reports of the Enterobacteriaceae Subcommittee (Rio de Janeiro and Rome). In these reports the family is subdivided into biochemical groups, not into tribes, genera, and species. Any further subdivision of the proposed groups must rest upon the recognition of known and delineated biochemical or serological types which occur within them. Such a classification is consistent with our present knowledge and of necessity must suffice for practical and scientific purposes until such time as it can be extended as a result of further developments in the field.

At present it is not possible to define a "genus" or a "species" in the Linnaean sense. For example, endless controversies arise in any discussion as to whether the Salmonella group should be regarded as a "genus" or as a "species." To avoid all these difficulties, it is better to abandon this artificial and arbitrary classification into "genera" and "species" and to subdivide the Enterobacteriaceae into biochemical groups, subgroups, and types as proposed by the Enterobacteriaceae Subcommittee.

Since it is wished to discuss here only the principles of classification, it is neither necessary to describe the several groups individually nor to present a table of their biochemical attributes. However, since the biochemical tests are the basis of classification, it is desirable to discuss some fundamental facts which are of importance in their interpretation and the recording of results.

The biochemical differentiation of groups is based on the whole picture of biochemical behaviour as it is presently understood, and not by the results of one or several tests (Kauffmann, 1954). To obtain this complete picture 30 or more tests may be required. However, in the determination of whether a culture belongs to one or the other of two groups, not all of these tests are of equal value and often it is possible to use fewer substrates.

In reading and reporting biochemical reactions, it is necessary to differentiate between four different results:

1) + = positive, 1-2 days. The majority of such cultures give a positive reaction after 1 day.

2) (+) = always positive, but delayed usually 3-4 days or longer. This reaction is relatively rare and the designation (+) should be used only if the constancy of this delayed reaction is proved in repeated tests with numerous cultures. A typical example of this reaction is the delayed fermentation of trehalose (+ 3-4) by Salmonella paratyphi C.

If it is not demonstrated that this delayed reaction is regularly delayed and always occurs at about the same time, it should be designated by the letter x (see below). Kristensen (1955) studied the fermentation reactions of several Salmonella types with regard to "primary slow" or "mutative" fermentation and found that a delayed fermentation was very often mutative.

3. x = late and irregularly positive or negative (usually mutative). For instance, this type of fermentation occurs in biochemical type 2 of S. typhi with regard to the fermentation of xylose. The differences between the two xylose-types of S. typhi are as follows:

Type 1 attacks xylose promptly (+), but type 2 ferments by mutation (= x), i.e., the fermentation of xylose is usually delayed and irregular or is lacking. It is incorrect to call this reaction a negative one, as positive reactions will be obtained when several tubes are incubated for long periods. When a loopful of a tube which became positive after some days is plated on agar containing xylose, colonies may be isolated which ferment xylose promptly and which will continue to do so. Although this mutative reaction is irregular, this irregular or variable behaviour is very constant and characteristic for the special type. The mutative reaction is the only variable reaction. The differential diagnosis between this mutative fermentation (x) and the delayed positive (primary slow) fermentation ((+)) is possible only on the basis of repeated tests of the same culture. In those instances where it has not been determined whether fermentation is primary slow or mutative, the symbol x may be used.

4) - = negative (the observation time should be at least 14 days).

Within many serotypes there occur several biochemical types which may give with the same substance any one of +, (+), x or - reactions. The sign "v" previously has been used to indicate "various biochemical types," but not to indicate "variable." The term "variable" should be avoided as it has caused misunderstanding and often is taken to mean "irregular." To avoid further misunderstanding it is proposed to designate "various or different biochemical types" by the letter "d" (from "different"). If, for example, one strain of S. paratyphi B ferments inositol promptly, but another strain of the same serotype does not attack this substance at all, this behaviour is not "variable," it is constant for both biochemical types which behave differently in this respect (= d). Here we have to do with two distinct types which differ in their action on inositol, but are absolutely constant in their biochemical behaviour.

When the biochemical reactions are judged correctly by +, (+), x, or -, many discrepancies in the literature and mixconceptions regarding the instability of biochemical reactions will disappear. It should be stressed that the signs x and d are different, as x means a delayed, usually mutative, reaction, and d means different biochemical types within a single serotype.

SUMMARY

Since a natural, genetic system of classification of the Enterobacteriaceae cannot as yet be established and as the artificial Linnaean system cannot be accepted, especially the Linnaean "species" concept, the Enterobacteriaceae are subdivided for practical purposes into biochemical groups and subgroups.

The biochemical tests which are the basis of this group differentiation should be judged and reported in a uniform manner and designated by + = positive, (+) = delayed positive (primary slow), x = late and irregularly positive or negative (usually mutative) and - = negative. If different biochemical types occur within a single serotype, this should be indicated by the letter "d." The word "variable" should be avoided,

as only the mutative reaction (= x) is irregular, but the mutative reaction is a constant and characteristic property of special biochemical types.

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STAPHYLOCOCCUS PYOGENES ROSENBACH

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In a recent paper, Cowan (4) presents an interpretation of the rules in the International Bacteriological Code of Nomenclature in support of the recognition of Staphylococcus aureus Rosenbach as the correct binomial for the name of the pus-forming staphylococcus. It is believed that the interpretation of the rules that he has presented needs further study, and that a closer study of the facts will show that the binomial Staphylococcus pyogenes (originally preferred by Cowan because of its appropriateness) is also the binomial that should be used because it is legitimate under the rules in the Bacteriological Code of Nomenclature.

As various editions of Bergey's Manual have been issued, opportunities for careful studies of the literature have presented themselves; This is particularly true of the years since the 6th edition of Bergey's Manual was published (1). It is the purpose of those in charge of editing the Manual to abide by the Rules in the Code of Nomenclature, with certain definite exceptions. a) In some cases it has been found that a strict interpretation of the Rules would cause us to use names that have priority but which have never been generally used. To introduce them in Bergey's Manual before appropriate action has been taken by the Judicial Commission would produce confusion in the literature. For example, Streptococcus nocardii Trevisan has not been used for the mastitis streptococcus (Streptococcus agalactiae Lehmann and Neumann) although the former binomial has clear priority. Recently the International Judicial Commission on Bacteriological Nomenclature agreed that Trevisan's name Streptococcus nocardii, never having come into general use, should be placed on the list of nomina rejicienda. b) In some cases where it has been found that a generic name is an illegitimate homonym of a generic name previously used in botany or protozoology, the illegitimate name has been continued in use in Bergey's Manual rather than to introduce a series of new binomials that would be new combinations. Such changes in nomenclature are preferably left to students of the particular group in question. These policies have been

followed in order to support two important principles of all codes of nomenclature. The primary aim of such codes is to provide stability in nomenclature; but a second, and likewise important aim, is to avoid the useless creation of new names.

In preparing the manuscript for the 7th edition of Bergey's Manual, which has now been sent to press, we, like Cowan, have again reviewed the status of the names Micrococcus Cohn, 1872 (3), and Staphylococcus Rosenbach, 1884 (11). While Micrococcus Cohn has priority over Staphylococcus Rosenbach, and may be used as the generic name for all mass-forming micrococci as was done in the 6th edition of Bergey's Manual, it has been realized that the use of the generic name Micrococcus for the pus-forming cocci causes the elimination of the commonly-used generic name Staphylococcus and the commonly-used binomial Staphylococcus pyogenes. A further study of the micrococci was therefore stimulated, whereupon several facts not previously fully recognized were discovered.

The micrococci include quite a number of species that have been studied carefully in recent years, that are very different in character from the pus-forming staphylococci. For example, there are certain micrococci found in soil that are active denitrifiers, producing N_2 and N_2O gases from nitrates. Some of these are obligate halophiles that are not able to live in brines of lower concentration than 4 or 5 per cent. Some of these require brines of 12 to 16 per cent for optimum growth. There are even red micrococci that will not grow in brines lower than 18 per cent. Some related red micrococci are motile, as are occasional strains of certain yellow micrococci. Some micrococci are able to grow at temperatures below freezing and are now being studied because they occur in foods preserved by freezing.

Organisms of these types are so different from the pathogenic staphylococci that it seemed possible to find a satisfactory basis for separating the genus Micrococcus Cohn, type species Micrococcus luteus Cohn, from Staphylococcus Rosenbach, type species Staphylococcus pyogenes Rosenbach. Such a basis has been reported by Winslow, Rothberg, and Parsons (15) and has been developed further by Evans, Bradford, and Niven (6).

The true micrococci either do not attack glucose at all, or utilize it in their metabolism with the liberation of small

amounts of CO_2 that may give a faint acid reaction. The true micrococci are such strict aerobes that they cannot grow anaerobically even when given as favorable a carbon source as glucose. On the other hand, the pus-forming staphylococci are able to ferment glucose anaerobically, and frequently other substances.

Such studies as have been made also indicate that the common white skin staphylococcus known as Staphylococcus epidermidis albus Welch (12) (see also Gordon, 7) can ferment glucose anaerobically. Further studies may show that more than these two species should be placed in the genus Staphylococcus, but in the manuscript that has been sent to press only these two species are recognized in the genus Staphylococcus.

Those who have not had occasion to study the literature do not realize that about 500 names have been given to purported species of micrococci or staphylococci. Many of the descriptions are almost exact duplicates, and almost all should be reviewed before acceptance. It takes 33 pages in the 6th edition of Bergey's Manual merely to give the bibliographical record of the names of these species. These organisms are common in their natural habitats but are listed in the appendix to Genus Micrococcus in the Manual because the original work with them has not been adequately evaluated.

Two noteworthy attempts have been made to bring some order out of this confusion. The work done by Winslow and Rogers was reported in two papers (13, 14) and then was summarized in their book (16) discussing the systematic relationships of the Coccaceae. Unfortunately, this book never received wide distribution. Only 13 species of the micrococci (mass-forming cocci) were accepted by the Winslows.

The Winslows' work was used by Hucker (8) in his still more extensive studies carried out at the New York State Agricultural Experiment Station, and at Yale University where Prof. Winslow was available for consultation. In his work, Hucker recognized 15 species out of the hundreds that had been described previously.

These monographic studies form the basis of the classification of the genus Micrococcus in the 6th edition of Bergey's Manual. In the arrangement presented in the 6th edition of the Manual, pyogenic staphylococci were recognized as two varieties of the species Micrococcus pyogenes.

Following the usage that had developed during the years, Staphylococcus pyogenes citreus Passet was incorrectly described as a species of the lemon-yellow micrococci, distinct from Staphylococcus pyogenes. More recently, a further study has been made of the status of the species.

While Cowan (4) was concluding that he was wrong in having previously accepted Staphylococcus pyogenes Rosenbach as the correct name for the type species of the genus Staphylococcus, we had concluded that under the rules Staphylococcus pyogenes Rosenbach was the correct binomial to use for the species which would include the orange and white staphylococci as well as the lighter yellow cultures of pyogenic cocci that Passet (10) named Staphylococcus pyogenes citreus. Cowan has given us a photostatic copy of the most important pages from the Rosenbach publication. He points out, for example, that the first names proposed by Rosenbach (11) for the pus-forming staphylococci (p.18) occur in the following sentence: "Zur Bezeichnung der beiden Arten schlage ich vorläufig bis die Botaniker diese Wesen mit passenden Bennungen in das allgemeine System eingereiht haben werden, nach der charakteristischen Farbe der Kulture die Staphylococcus flavus oder aureus und Staphyl. albus vor."

There are two words in this sentence that deserve thought and careful study. One is the word "Arten" which English-speaking persons, especially those interested in taxonomy, normally give the technical meaning "species;" the other word is "vorläufig," which may be translated as "preliminary" or "provisional."

In checking the meaning of "Art" in a German dictionary, it was discovered that the word "Art" is a common German word. While it may be given the technical meaning "species" this is not the usual meaning of the word. Rosenbach did not intend to name two "species" as many think, but is merely speaking of two "sorts" or "kinds" of pus-forming cocci. A German-speaking friend was consulted and he, without any suggestion on my part, translated "Arten" as "sorts of." He felt that the meaning "species" was rare and unusual. Rosenbach, a clinician not trained in botanical taxonomy does not indicate that he was describing two "species."

Cowan (4) speaks of Staphylococcus pyogenes aureus and Staphylococcus pyogenes albus as trinomials, forgetting that this is the correct form to use for varietal names. An example of the correct way in which to write subspecies or

varietal names is given in the Bacteriological Code (2) under Rule 7. Varietal names of subspecific names may be correctly written as Staphylococcus pyogenes subsp. aureus, Staphylococcus pyogenes var. aureus, or even as Staphylococcus pyogenes aureus.

A careful reading of Rosenbach's description of the staphylococci that he isolated from aseptically drawn pus, indicates that he was describing two sorts of these staphylococci; one that grew with an orange color, and the other that grew without showing chromogenesis. As Cowan points out, he did not in any place in his publication use Staphylococcus pyogenes without the addition of the varietal epithets. He, however, indicates that he is not familiar with the procedures used by botanists. At that time there was no such rule in codes of nomenclature as that now given in the last paragraph of Rule 7 (2) which states that "The subspecific epithet of the subspecies containing the type of the species shall be the same as that of the species." Rosenbach did the very natural thing for anyone not trained in the modern technical requirements of codes of nomenclature and designated the orange variety as aureus and the white variety as albus.

Before turning to other evidence that supports this interpretation of Rosenbach's intent, brief mention should be made of the reason no mention is made in Bergey's Manual of Staphylococcus flavus Rosenbach as a possible name for the orange to yellow colored staphylococcus. This is because of Rosenbach's use of the word "vorläufig." Preliminary or provisional names suggested by an author but not accepted by him are not validly published and have no standing whatever from the standpoint of nomenclature (2; Rule 12, 4th par.). Dozens, yes hundreds, of binomials have been ignored in Bergey's Manual that occur in the literature but which are not validly published. Authors frequently list synonyms that are not validly published, never having been used by the person to whom they are ascribed.

It is significant that German workers contemporary with Rosenbach accepted Staphylococcus pyogenes as the binomial proposed by him for the species under discussion. Thus, Passet (10) apparently is the first to have actually used Staphylococcus pyogenes without an attached varietal name. His work has likewise been very much misunderstood. Many subsequent authors have described lemon-yellow micrococci under the name Staphylococcus pyogenes citreus or Staphylo-

coccus citreus that clearly are not the Staphylococcus pyogenes citreus that Passet had in front of him. Passet studied the staphylococci present in aseptically drawn pus as did Rosenbach. He proposed the name Staphylococcus pyogenes citreus merely as a varietal name to be applied to organisms that formed lighter yellow colonies that were mixed with the darker yellow (aureus) colonies, as shown in his figure. He speaks of the darker yellow colonies as being more orange colored and the lighter yellow colonies as being more lemon colored. In further studies of the organism in the yellow colonies he found it to be pathogenic for rabbits, guinea pigs, and white mice, as also were the organisms in the orange and white colonies. He also gives other characters which show that his Staphylococcus pyogenes citreus was a variety of Staphylococcus pyogenes.

Passet presents the names for these pus-forming staphylococci in a section beginning on page 8 of his book. This section bears the title "Staphylococcus pyogenes aureus, albus, citreus." The first sentence of this section reads:

> "Der Staphylococcus pyog. findet sich im Eiter der Menschen und Thiere am Häufigsten einzeln oder als Doppelkokkus."

In other wirds, Passet accepts the thought that Rosenbach was merely indicating two sorts of pus-forming staphylococci belonging to the species Staphylococcus pyogenes.

Lehmann and Neumann (9), who had a much clearer understanding of taxonomic principles and procedures than did Rosenbach, likewise accept pyogenes as the specific epithet proposed by Rosenbach, using it in the binomial Micrococcus pyogenes (Rosenbach) Lehm. and Neum. Under this species they recognize three varieties: α aureus (Rosenbach) Lehm.; β citreus (Passet) Lehm. and Neum.; γ albus (Rosenbach) Lehm. and Neum.

It seems clear that Germans understood Rosenbach's work as one that proposed a description of a species which showed variation in its chromogenesis as indicated by the subspecific epithets aureus and albus.

CONCLUSION

It is recommended that the Judicial Commission recognize the valid and legitimate status of the generic name Staphylococcus Rosenbach 1884, for use wherever it is desired to subdivide the aerobic to facultatively anaerobic mass-forming cocci into two genera. The type species in this case would be Staphylococcus pyogenes Rosenbach. The culture recommended by Cowan, Shaw, and Williams (5) might well serve as the type culture for this type species.

It is recommended that Staphylococcus pyogenes aureus, Staphylococcus pyogenes albus, and Staphylococcus pyogenes citreus be accepted as names indicating varieties of the species Staphylococcus pyogenes without insisting that the name of the type variety be changed as required by Rule 7.

If the interpretation of the facts presented here is regarded by the Judicial Commission as correct, these recommendations would preserve for us in suitable fashion the generic and specific names that have been most generally used throughout bacteriological literature. While usage is not definitely recognized as a basis for establishing names under either the most recent Botanical or Bacteriological Codes, it forms, nevertheless, a sound basis by which to determine whether generic or specific names should be placed on lists of nomina conservanda. This is already recognized in some of the decisions rendered by the Judicial Commission.

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NOMENCLATURAL NOTES

The International Rules of Zoological Nomenclature

The XIV International Congress of Zoology held in Copenhagen, 1953, approved the content of the Revised International Rules of Zoological Nomenclature, and directed that they be edited for publication. The literature bearing upon the revision of the "Rules" is voluminous and detailed, it is phrased carefully and usually quite legalistically. The zoologists charged their International Commission on Zoological Nomenclature with the task of preparing draft copy for the revision to be finally approved at the Copenhagen Congress of 1953. This Commission held fifteen meetings in Paris in July, 1948, at the time of the XIII International Congress. Practically the entire Volume 4 (parts 1-24, 1950) of their official organ "THE BULLETIN OF ZOOLOGICAL NOMENCLATURE" is given over to the "Official Record of Proceedings of the International Commission on Zoological Nomenclature." Including the excellent index, there are 760 pages. On December 31, 1953, there was published the "Copenhagen Decisions on Zoological Nomenclature of the Règles Internationales de la Nomenclature Zoologique" adopted by the Copenhagen Congress, August, 1953, and edited by Mr. Francis Hemming. At this Congress Mr. Hemming was authorized to proceed with the preparation of the Official Records of the Copenhagen meetings and Prof. J. Chester Bradley, President of the International Commission was invited to prepare the first draft of the revised rules. These rules have not yet (Jan. 15, 1956) been published, so they are not available in final form.

The meaning of the revised rules may be gleaned from the publications noted above, but the pertinent statements are scattered through fifteen hundred pages or more. Fortunately, Dr. W.I. Follett, of the California Academy of Science, has prepared, and the Society of Systematic Zoology in the United States of America has printed and distributed a most helpful brochure. Because of the restrictions placed by the International Zoological Trust upon publication of quotations from their copyrighted publication, the brochure includes in its title "An unofficial interpretation of the International Rules of Zoological Nomenclature" and the cover bears the statement "Issued September 1955. Not published."

The booklet (100 pp.) is paraphrased from the "Bulletin of Zoological Nomenclature" and the "Copenhagen Decisions." The material is well organized, includes a glossary, and has an excellent index. The author states clearly that; "it should not be quoted as an authority for any nomenclatural proposition."

The Glossary is of interest in showing the development of a terminology which has come to differ in many respects from that of Botany and Bacteriology. These differences in use of terms are particularly significant to the microbiologist working with the protozoa, and are of interest to all biologists. Some of the differences are noteworthy:

Binary nomenclature (the binomial nomenclature of the bacteriologist) has been replaced by "binominal nomenclature."

Binomen is introduced as the standard expression to indicate the name of a species, replacing the older designations, species name and specific name. It is the binominal designation which constitutes the scientific name of a species. The wisdom of this rechristening of the species name may well be debated. There is no classic Latin word binomen, but the adjective binominis is defined as "having two names." One is puzzled to find that the name of a species has two names.

Specific name. The Paris (1948) Zoological Congress defined "specific name" as the scientific name of a species. The Copenhagen (1953) Congress as noted above replaced the phrase "specific name" by "binomen." It then redefined "specific name" as the "name" that distinguishes a "nominal species" from the other species of that "nominal" genus. In other words, a specific name is the designation of the second component of the name of a species. The term used for this in bacteriology and botany is specific epithet. The terms specific name and species name are not synonymous in zoology as they are in bacteriology. Most specific epithets (specific names in zoology) are adjectives: there is some element of anomaly in terming a descriptive adjective such as "aureus" a name. There is merit in the appellation of "epithet."

Trivial name. The designation of the second component of the name of a species was fixed by the Paris Zoological Congress as the "trivial name." This was discarded by the Copenhagen Congress and replaced by "specific name." The

term "trivial name" in zoology is a synonym of "specific epithet" in bacteriology. This lack of uniformity in terminology, the use of the same term with different meanings in the several branches of biology, is most confusing and unfortunate. Apparently there has been no effort among the several branches of biology to cooperate in eliminating discordant terminology.

Trinomen is the designation of the name of a subspecies, consisting of the name of the genus followed by the "specific name" (specific epithet) and this in turn by the "subspecific name" (subspecific epithet). The corresponding term in bacteriology is subspecific or subspecies name.

Subspecies is defined as a population (e.g., geographic or ecological) within a species that is to be distinguished from any other such population within the same species.

Opinion and declaration are distinguished. An opinion is a decision by the Commission having to do with the status of a name or book. A declaration is a decision by the Commission which interprets a rule. In the Bacteriological Code both are included in "Opinions."

Infrasubspecific form. A term used to designate any form (subdivision) of a species, other than a subspecies, such as seasonal, sexual and transitional forms, aberrations and minority elements of all kinds within a species. In spite of its length, infrasubspecific may be useful as an over-all term to include in bacteriology the subdivisions of species such as serotype, strain, stage, group, phase, and others.

Nominal. The Zoological Rules recognize the use of the term genus in two senses. In a general sense genus is the name applied to that taxon made up of related species, it designates a definite taxonomic category. A nominal genus is a particular genus which has been characterized and to which a distinctive name has been given. Experience has shown that when used in the rules and recommendations of a code the two related but distinct usages of the word genus should be distinguished. This distinction will be made in the Zoological Rules when published. Similarly, species is the name given to a taxon of a definite rank; a nominal species is one which has been defined and named.

Homonym. A homonym is defined as the same name applied to two or more different units of the same taxonomic category (genus or species); the name of each is a homonym of the other. When two nominal species are given the same

name (binomen) in the same original publication, the binomina (species names) are primary homonyms. When two nominal species, at the time of the publication of their respective names, are placed in different nominal genera and are given the same specific name (specific epithet), and are subsequently placed in the same nominal genus, each binomen (species name) is a secondary homonym of the other.

Clearly many of the definitions and new terminologies to be included in the revised Zoological Rules may well be considered in revision and interpretation of the rules and recommendations of the Bacteriological Code. One may, however, hesitate to accept the dictum that an adjective (albus, achrous) or a noun in the genitive (enteritidis, suis) which appears as the second component of the name of a (nominal) species is to be regarded as a name, as in the expression "specific name" approved for use in zoology. There are some manifest advantages in the continued use by bacteriologists of the grammatically correct phrase, specific epithet.

One may note some inaccuracies in the statements to be included in the revised Zoological Rules. In an appendix termed the "Second Schedule" there is given a table which "indicates the manner in which Greek words should be transliterated." The table includes several errors. In most cases there is no exact transliteration of the Greek word used as an illustration. As an example of an error, the Latin equivalent of the Greek omega (ω) is given as oe. It should be long o (ō).